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Roller With Salient Members

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BACKGROUND

1. Field of the Invention

[0001] The present invention relates to a roll and, more specifically, to a roll which includes salient members for forming fold lines on a substrate material.

2. Related Art

[0002] Deposition systems have been created for the deposition of metal, oxides, or similar materials onto continuously wound thin substrates, such as paper, plastic film, metal foil and the like. The wound or rolled thin substrates can be used, for example, as packaging material, capacitors and magnetic tape.

[0003] Unfortunately, rolled thin substrates are easily warped during processing. As illustrated in FIG. 1A, typically, the warped area 100 may be created by the expansion of the substrate (i.e. bulging) which occurs when the thin substrate is exposed to heat or when the thin substrate has formed wrinkles, during the rolling process.

[0004] Wrinkles or bulges 102 formed on the thin substrate 104 make it difficult to properly and adequately deposit vaporized materials 106 thereon. For example, in a vacuum deposition process, vaporized materials 106 travel upward (vertically) to be deposited on a relatively flat surface of the substrate.

[0005] As shown in FIG. 1B, the bulged area is not flat, thus, causing a portion of the bulged area to be inadequately covered with vaporized material. The sides of the bulged area, which are not covered, form lines known as “rails” on the substrate.

[0006] What is need is a roll that can reduce or eliminate warping and thus remove the cause for the formation of rails and similarly destructive formations.

SUMMARY

[0007] The present invention provides a roll of a roller assembly that can reduce or eliminate the formation of bulges and wrinkles that create warped areas on thin substrate materials.

[0008] In accordance with an aspect of the present invention, a roll is provided for feeding substrate material. The roll includes a sheet roller, which has a circumference and a surface layer, configured to rotate about a first axis. A plurality of salient members are disposed on the surface layer to extend along the first axis at intervals about the circumference. Each of the plurality of salient members is configured to cause a fold line to form across a width of the substrate material, which is substantially perpendicular to a direction of travel of the substrate material.

[0009] In another aspect of the present invention, a method is provided which includes feeding a sheet of substrate material into a sheet roller. The sheet roller has a circumference and a surface layer and is configured to rotate about a first axis. The method also includes forming a fold line across a width of the sheet of substrate material, which is substantially perpendicular to a direction of travel of the sheet of substrate material. as the sheet of substrate material contacts at least a portion of the sheet roller.

[0010] In yet another aspect of the present invention, a roll is provided for feeding substrate material. The roll includes a sheet roller, having a circumference and a surface layer, configured to rotate about a first axis and; and a means for forming a fold line across a width of the substrate material, which is substantially perpendicular to a direction of travel of the substrate material.

[0011] Advantageously, the sheet roller including the plurality of salient members causes fold lines to be formed across the width of the substrate material, as the substrate material is wound about the roll. The fold lines increase the tensile strength of the substrate material across the width, which increase the resistance of the substrate material to unwanted expansion due to heat and to the unwanted formation of wrinkles.

[0012] Depending on the specifications of the substrate material, the radius of the fold lines, the interval between the fold lines and the pitch of the fold lines can be

tailored by modifying the size and shape of the salient members. Fold lines can be formed on the top and bottom surfaces of the substrate material to further increase the strength of the material.

[0013] Beneficially, if the substrate material can be wound through the roll without forming warped areas, the substrate material is in a better condition for being subjected to various forms of deposition, such as vacuum deposition and other deposition techniques at ambient pressure and temperature, which reduces or eliminates detriments, such as the formation of rails.

[0014] The fold lines formed by the present invention are very small and therefore cannot be detected by the naked eye. Moreover, the fold lines do not cause a detriment to any deposition processes. In addition, the fold lines are easily removed from the substrate material with minimal further processing.

[0015] These and other features of the present invention will be more readily apparent from the detailed description of the embodiments set forth below taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

[0016] FIGS. 1A and 1B are simplified side and front views, respectively, of a thin substrate undergoing a deposition process;

[0017] FIG. 2 is a simplified illustration of a roll in accordance with an embodiment of the present invention;

[0018] FIG. 3 is a simplified illustration of an embodiment of a sheet roller in accordance with an embodiment of the present invention;

[0019] FIG. 4A is a simplified side view showing a roll with salient members in accordance with an embodiment of the present invention;

[0020] FIGS. 4B and 4C are simplified illustration of alternative embodiments of salient members in accordance with the present invention;

[0021] FIG. 5 is a simplified illustration of a portion of a substrate material having fold lines in accordance with an embodiment of the present invention;

[0022] FIG. 6A is a simplified illustration of an operational embodiment of a roll having flat bars in accordance with an embodiment of the present invention; and

[0023] FIGS. 6B-6E are simplified cross sectional views of the width of a substrate material.

[0024] A detailed description of embodiments according to the present invention will be given below with reference to accompanying drawings

DETAILED DESCRIPTION

[0025] FIG. 2 is a simplified illustration of roll 200, which includes a roller shaft 202 and a sheet roller 204. It should be understood that the construction of roll 200 can be accomplished using any conventional parts and manufacturing techniques.

[0026] In one exemplary embodiment with no intent to limit the invention, as FIG. 2 shows, sheet roller 204 can be rotatably mounted on a plurality of casings housing bearings on roller shaft 202. Sheet roller 204 may be configured to have many shapes, for example, sheet roller 204 can have an outer circumference that is constant or, which gradually increases or decreases progressively in an axial direction from its central part toward its opposite end parts.

[0027] In this embodiment, end flanges 206 can be fitted in the end parts of sheet roller 204. Set flanges 208 can be mounted on the external sides of the end flanges. Set sleeves 210 can be fitted onto roller shaft 202. Gears 212 may be used to transmit a drive force for rotation of sheet roller 204.

[0028] The length and diameter of sheet roller 204 can be made as desired for a particular application. In one embodiment, with no intention to limit the invention, the length of sheet roller 204 can be between about 300 mm and about 20,000 mm. The diameter of sheet roller 204 can be varied, but depends on the characteristics of the thin substrate material, such as the thickness, width, flexibility, tensile strength and the like. In one embodiment, the diameter of sheet roller 204 can range between about 50 mm to about 1,000 mm.

[0029] The length and diameter of roller shaft 202 can be made as desired for a particular application. No special limit is put on the sectional structure and the specifications of the roller shaft. An example of a roll is fully disclosed in U.S. Patent No. 4,872,246, which is herein incorporated by reference for all purposes.

[0030] FIG. 3 is a simplified illustration of an embodiment of sheet roller 204 in accordance with the present invention. In this embodiment, sheet roller 204 includes a plurality of salient members 302 positioned about the circumference of sheet roller 204. Salient members 302 extend the longitudinal length of sheet roller 204 and may be mounted to sheet roller 204 by using an adhesive or similar substance.

Alternatively, salient members 302 can be formed into sheet roller 204 during fabrication of the sheet roller, such as by molding, casting or machining.

[0031] The number of salient members 302 mounted or formed on sheet roller 202 can vary based on the number of fold lines 502 desired to be formed on substrate S (FIG. 5).

[0032] Salient members 302 can be made of any material that is capable of providing support against compression forces created by the substrate material being wound thereon, such as resin, including plastics, metal, paper and the like.

[0033] FIG. 4A is a simplified side view of resilient members 302 coupled to sheet roller 204. FIG. 4B shows an embodiment of salient member 302 as flat bar 400, which can have a substantially rectangular cross-section. The substantially rectangular cross section of flat bar 400 makes flat bar 400 suitable for use with thin substrate materials, such as those materials having a thickness of between about 0.003 mm and about 0.030 mm. The length of flat bar 400 is generally equal to the length of the sheet roller. In one embodiment, the length ranges from between about 300 mm and 20,000 mm. The height h of flat bar 400 can be varied as a function of the diameter of roll 200. In one embodiment, the thickness h of flat bar 400 can range between about 0.1 mm and about 1 mm. The width w of flat bar 400 can also vary depending on the application, for example, between about 5 mm and about 20 mm.

[0034] FIG. 4B illustrates a single flat bar 400, which includes rounded corners 402 and 404. The radius r of rounded corners 402 and 404 determines the angle at which fold lines 502 are formed onto substrate material S (FIG. 5). In one embodiment, radius r can range from between about half the thickness of flat bar 400 to twice the thickness of flat bar 400. For example, radius r can range from between about 0.05 mm to about 2 mm. Accordingly, the fold line angles formed on substrate material S also have a radius r equivalent to the angle of the rounded corners 402 and 404, which are not acute angles to avoid causing permanent damage to the substrate material.

[0035] As shown in FIG. 4C, in another embodiment, the salient members 302 can have a substantially circular cross-section, such as shown as round bar 406. The substantially circular cross section of round bar 406 makes round bar 406 suitable for use with thin substrate materials, such as those materials having a thickness of

between about 0.003 mm and about 0.030 mm. In one embodiment, round bar 406 has a diameter of between about 0.1 mm and about 4 mm.

[0036] Referring now to FIGS. 6A-6E, in one operational embodiment, substrate material S is pulled around roll 200 and salient members or flat bars 604 as roll 200 is made to rotate. As substrate material S is pulled in the direction of travel indicted by arrow 602, mechanical vibration as well as slip efficiency defined by the Law of Pulling cause the pulling force to be greater in the center of the material, in turn, causing the peripheral portions of substrate material S to move toward the center. This phenomenon causes the width of substrate material to narrow creating wrinkle waves, such as those shown in FIG. 6B. As the material approaches the first flat bar 604 to which it shall make contact, in this embodiment, flat bar 604a, the wrinkle waves become considerably smaller (FIG. 6C and FIG. 6D). Upon reaching flat bar 604a, the pulling force causes the substrate material S to be pulled down to flat (FIG. 6E).

[0037] Without flat bars 604, the width of substrate material S is stretched (made wider) or is pushed to the center (made narrower). However, as the material winds around flat bars 604 on roll 200 the wrinkle waves are flattened while fold lines 502 are formed across the width of substrate material S in even intervals as shown in FIG. 5. The fold lines are not formed of an acute angle.

[0038] As shown in FIG. 5, fold lines 502 are formed with an apex across the width of substrate material S, the fold lines increase the tensile strength across the width of the substrate, which makes substrate material S stronger across the width and thus more resistant to heat expansion, which leads to bulging and to forces which cause the material to stretch and shrink, which can cause wrinkle waves, which leads to the formation of warped areas.

[0039] Since strengthening substrate material S reduces bulges and warped areas, substrate material S can be subjected to vapor deposition or other coating techniques without forming rails or other detrimental affects related to wrinkles and bulges.

[0040] Referring again to FIG. 5, in an alternative embodiment, substrate material S can be made to wind around a first roll creating fold lines, such as fold lines 502 with an apex on a first surface 506 of substrate material S. The material can then be fed to a second roll that causes the formation of fold lines, such as fold lines 504 having an apex on a second surface 508 of substrate material S. Substrate materials

which have fold lines on both surfaces of the material have an even stronger resistance to the formation of wrinkle waves.

[0041] Fold lines 502 and 504 are generally made so thin as to not be visible to the naked eye. Moreover, the fold lines are easily removed from substrate material S after processing, such as deposition processing. In one embodiment, fold lines 502 and 504 can be removed by using a meanderless roller. In general, the meanderless roller is an expansion roller, which can be used to remove wrinkles in the substrate material.

[0042] The meanderless roller is a roll including a curved shaft upon which is rotatably mounted an elastic roller which has its circumference increasing progressively from its center to its ends. The article to be passed contacts the parts of the roller closest to the ends with the larger diameter and passes in a stable manner without distortion or permanent set therein.

[0043] Consequently, the areas of the substrate material at the ends receive a higher pulling force extending the same in its cross-wise direction than the center area of the substrate material. This causes the substrate material to be stretched out in the cross-wise direction. This force makes it possible to stretch out any wrinkles or fold lines in the article to be passed.

[0044] A meanderless roller is fully described in United States Patent No. 4,872,246, which is herein incorporated by reference for all purposes.

[0045] Having thus described embodiments of the present invention, persons skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. Thus the invention is limited only by the following claims.